

## CLAIMS

What is claimed is:

1. A method for controlling an electronically servo-assisted bicycle gearshift (8), comprising the steps of:

a) driving (405,413) an actuator (16, 17) of a bicycle gearshift (8) to displace a chain (13) of the gearshift in a chosen axial direction (A, B) with respect to a gearshift group (9, 10) having a plurality of sprockets including at least two adjacent sprockets,

b) receiving information in a control unit on a desired alignment (406, 414) between the chain (13) and a predetermined sprocket (11, 12) of the gearshift group (9, 10), and

c) setting (404, 409, 412, 416) an adjustment variable (R-OFFSET<sub>x</sub>, F-OFFSET<sub>y</sub>), in a control unit, of a logic value associated with a gear ratio relative to the predetermined sprocket (11, 12) to a value corresponding to the displacement carried out in step a) of driving the actuator (16, 17).

2. The method of claim 1, wherein the adjustment variable (R-OFFSET, F-OFFSET) is common to all the gear ratios of the gearshift group (9, 10).

3. The method of claim 1, wherein the adjustment variable (R-OFFSET<sub>x</sub>, F-OFFSET<sub>y</sub>) is one of a plurality of adjustment variables (R-OFFSET<sub>x</sub>, F-OFFSET<sub>y</sub>), each associated with a gear ratio.

4. The method of claim 1, further comprising the step of:

d) receiving (402, 410) a displacement request signal of the actuator (16, 17) in the chosen direction, wherein in step a) of driving the actuator (16, 17), the displacement of the chain (13) is carried out in accordance with the displacement request signal (402, 410) received in step d).

5. The method of claim 4, wherein step d) of receiving (402, 410) a displacement request signal and step a) of driving the actuator (16, 17) are repeated until receiving the information on the desired alignment (406, 414) in step b).

6. The method of claim 5, further comprising the step of:  
e) subordinating the repetition of step a) of driving the actuator (16, 17) to a check (403, 408, 411, 415) that the displacement carried out in step a) has not reached a maximum displacement value.

7. The method of claim 6, wherein the maximum displacement value is lower than half the distance between the two adjacent sprockets (11, 12) of the gearshift group (9, 10) if the predetermined sprocket (11, 12) is a sprocket (11, 12) with the largest or smallest diameter, respectively, of the gearshift group (9, 10), otherwise it is equal to half the distance between two adjacent sprockets (11, 12) of the gearshift group (9, 10).

8. The method of claim 5, further comprising the steps of:  
f) receiving an operating mode signal selected from the group consisting of at least a normal ride operating mode (102) and an adjustment operating mode (117);  
g) receiving a displacement request signal (43, 44, 45, 46) of the actuator (16, 17) to displace the chain (13) in the chosen axial direction (A, B) with respect to the gearshift group (9, 10);  
h1) wherein when the operating mode signal corresponds to the adjustment operating mode (117), at least steps a)-c) are carried out;  
h2) wherein when the operating mode signal corresponds to the normal ride operating mode (102), the step of driving the actuator (16, 17) of the gearshift (8) to displace the chain (13) of the gearshift (8) in the chosen axial direction (A, B) with respect to the gearshift group (9, 10), between the physical position corresponding to a first sprocket (11, 12) of the gearshift group (9, 10) and the physical position

corresponding to a second sprocket (11, 12) of the gearshift group (9, 10) is carried out, the physical positions being determined by the logic values associated with the sprockets as adjusted by the adjustment variables (R-OFFSETx, R-OFFSETy).

9. The method of claim 8, wherein step h2) further comprises driving the actuator (16, 17) to displace the chain (13) in the chosen axial direction (A, B) a distance determined by modifying the value of a counter (47, 48) by an amount equal to an algebraic sum of a common adjustment variable (R-OFFSETx, F-OFFSETy) or the adjustment variable associated with the gear ratio relative to the second sprocket (11, 12) and a difference (Fi+1-Fi, Rj+1-Rj, ΔRx, ΔFy) between the logic values associated with the second sprocket (11, 12) and with the first sprocket (11, 12).

10. The method of claim 9, wherein the difference (Fi+1-Fi, Rj+1-Rj, ΔRx, ΔFy, ΔF, ΔR) between the logic values associated with the second sprocket (11, 12) and with the first sprocket (11, 12) is indicated by at least one differential amount (ΔFx, ΔRy, ΔF, ΔR) pre-associated with each pair of adjacent sprockets (11, 12) of the gearshift group (9, 10).

11. The method of claim 8, wherein the operating mode signal is selected from the group also consisting of a setting operating mode (114), and further comprising the step of:

h3) when the operating mode signal corresponds to the setting operating mode (114), carrying out the steps of:

h31) driving (207, 211, 307, 311) the actuator (16, 17) to displace the chain (13) of the gearshift in the chosen axial direction (A, B) with respect to the gearshift group (9, 10);

h32) receiving information on the desired alignment (205, 305) between the chain (13) and a predetermined sprocket (11, 12) of the gearshift group (9, 10),

h33) setting (215, 315) a biunique correspondence between the physical position of the actuator (16, 17) at step h32) and the logic value associated with the gear ratio relative to the predetermined sprocket (11, 12);

h34) zeroing the adjustment variable(s) (R-OFFSET<sub>x</sub>, F-OFFSET<sub>y</sub>).

12. The method of claim 11, wherein the predetermined sprocket (11, 12) in step h3) is the sprocket with the smallest diameter of the gearshift group (9, 10).

13. The method of claim 11, wherein the step h33) of setting (215, 315) a biunique correspondence comprises setting the value of a counter (47, 48) to said logic value pre-associated with the predetermined sprocket (11, 12).

14. The method of claim 13, wherein the step h33) of setting (215, 315) a biunique correspondence comprises zeroing the counter (47, 48).

15. The method of claim 11, wherein the step h33) of setting (215, 315) a biunique correspondence comprises storing in storage means (49, 50) the current value of a counter (47, 48) as the logic value (F<sub>x</sub>, R<sub>y</sub>) pre-associated with the predetermined sprocket (11, 12).

16. The method of claim 15, wherein the step h3) is repeated for each sprocket (11, 12) and a corresponding logic value (F<sub>x</sub>, R<sub>y</sub>).

17. The method of claim 4, further comprising the step of providing an immobile bicycle for performing the steps on.

18. The method of claim 4, further comprising the step of providing motion to the chain.

19. The method of claim 4, further comprising the steps of:
  - i) providing a user interface (43-46, 60-63), wherein the displacement request signal of the actuator (16, 17) is received through the user interface (43-46, 60-63).
20. The method of claim 19, wherein the information on the desired alignment is received through the user interface (43-46, 60-63).
21. The method according claim 4, further comprising the step of:
  - j) providing means for detecting the relative position between the chain (13) and the predetermined sprocket (11, 12) and providing the information on the desired alignment.
22. The method of claim 21, wherein the means for detecting the relative position between the chain (13) and the predetermined sprocket (11, 12) is also suitable for providing the displacement request signal of the actuator (16, 17).
23. The method of claim 1, further comprising the steps of:
  - k) driving the actuator (16, 17) of the gearshift (8) to displace the chain (13) of the gearshift in the chosen axial direction (A, B) with respect to the gearshift group (9, 10), from an initial position sequentially to each adjacent sprocket (11, 12) of the gearshift group (9, 10);
  - m) receiving second information on the desired alignment between the chain (13) and a predetermined sprocket (11, 12) of the gearshift group (9, 10).
24. The method of claim 23, further comprising the step of:
  - k1) driving the actuator (16, 17) of the gearshift (8) to displace the chain (13) of the gearshift in the chosen axial direction (A, B) with respect to the gearshift group (9, 10) sequentially at each adjacent sprocket (11, 12) of the gearshift group (9, 10) up to the predetermined sprocket (11, 12).

25. The method of claim 1, further comprising the step of driving the actuator at a plurality of operating speeds.

26. The method of claim 1, further comprising the step of selectively driving a stepper motor of the actuator by a first set number of steps and selectively driving the stepper motor by a second set number of steps greater than the first set number of steps to displace the chain (13).

27. A bicycle gearshift (8), comprising:

a rear actuator (16) and a front actuator (17), having a respective motor to displace, through a guide element (14, 15), a chain (13) in an axial direction (A, B) with respect to a respective gearshift group (9, 10) comprising at least two sprockets (11, 12) respectively associated with the hub of the rear wheel (4) and with the axle of the pedal cranks (7) of a bicycle (1), in a selected direction;

manual input means (43-46, 60-63) comprising means (43-46) for entering a signal requesting displacement of a selected actuator (16, 17), respectively, in the selected direction; and

an electronic control unit (40) connected to the input means (43-46, 60-63), to the rear actuator (16) and to the front actuator (17), operating, in normal ride operating mode (102), to drive the selected actuator (16, 17), respectively, based upon the displacement request signal to displace the chain (13) from a first sprocket (11,12) to a second adjacent sprocket (11,12) of the respective gear-shift group (9, 10);

wherein the manual input means (43-46, 60-63) comprises means (60-63) for selecting the operating mode at least between said normal ride operating mode and an adjustment operating mode,

wherein the electronic control unit (40), in the normal ride operating mode, drives the selected actuator (16, 17), between a logic value associated with the first

sprocket (11, 12) and a logic value associated with the second sprocket (11, 12), modified by the value of an adjustment variable (R-OFFSET<sub>x</sub>, F-OFFSET<sub>y</sub>), and

wherein the electronic control unit (40) is operative, in the adjustment operating mode, to drive the selected actuator (16, 17) based upon the displacement request signal to displace the chain (13) in the selected direction and to increase or decrease the value of the adjustment variable (R-OFFSET<sub>x</sub>, F-OFFSET<sub>y</sub>), the electronic control unit (40) also having means (60-63, 406, 414) for inputting information on the desired alignment between the chain (13) and a predetermined sprocket (11, 12) of the gearshift group (9, 10) to switch from the adjustment operating mode to the normal ride operating mode.

28. The gearshift of claim 27, wherein the adjustment variable (R-OFFSET, F-OFFSET) is common to all the gear ratios of the gearshift group (9, 10).

29. The gearshift of claim 27, wherein the adjustment variable (R-OFFSET<sub>x</sub>, F-OFFSET<sub>y</sub>) is one of a plurality of adjustment variables (R-OFFSET<sub>x</sub>, F-OFFSET<sub>y</sub>), each associated with a gear ratio.

30. The gearshift of claim 27, wherein the electronic control unit (40) comprises at least one counter (47,48), means for updating the counter during the driving of the selected actuator (16, 17) and means for comparing the value of the counter (47, 48) with logic values.

31. The gearshift of claim 30, wherein the operating modes, which can be selected by the operating mode selection means (60-63), further comprise a setting operating mode and in that the electronic control unit (40) is operative, in the setting operating mode, to drive the selected actuator based upon the displacement request signal to displace the chain (13) in the selected direction, the electronic control unit (40) also having means (43-46, 60-63) for inputting information on the

desired alignment between the chain (13) and a predetermined sprocket (11, 12) of the gearshift group (9, 10), and means (215, 315), responsive to the means (43-46, 60-63) for inputting information on the desired alignment, for setting a biunique correspondence between the physical position of the selected actuator (16, 17), respectively, and a logic value associated with the predetermined sprocket (11, 12).

32. The gearshift of claim 31, wherein:

the means (215, 315) for setting a biunique correspondence comprises means (215, 315) for setting the value of the at least one counter (47, 48) to the logic value pre-associated with the predetermined sprocket (11, 12).

33. The gearshift of claim 32, wherein the predetermined sprocket (11, 12) is the sprocket (11, 12) with the smallest diameter and the means (215, 315) for setting a biunique correspondence comprises means for zeroing the rear or front counter (47, 48).

34. The gearshift of claim 31, wherein:

the means for setting a biunique correspondence comprises means for storing in storage means (49, 50) the current value of the counter (47, 48) as the logic value pre-associated with the predetermined sprocket (11, 12).

35. The gearshift of claim 27, further comprising means for storing a differential amount ( $\Delta R_x$ ,  $\Delta F_y$ ) pre-associated with each pair of adjacent sprockets (11, 12), wherein in the normal ride operating mode the logic value associated with the second sprocket (11, 12) is determined by adding the differential amount pre-associated with the pair formed by the first and second sprocket (11, 12) to the logic value associated with the first sprocket (11, 12).

36. The gearshift of claim 35, wherein the differential amounts ( $\Delta R$ ,  $\Delta F$ )

pre-associated with each pair of adjacent sprockets (11, 12) of the gearshift group (9, 10) are equal to each other.

37. The gearshift of claim 27, further comprising at least one transducer (18, 19) for detecting the physical position of the selected actuator (16, 17) and providing it to the electronic control unit (40).

38. The gearshift of claim 37, wherein in the normal ride operating mode, the electronic control unit (40) drives the selected actuator (16, 17) to displace the chain (13) between the first sprocket (11, 12) and the second sprocket (11, 12) feedback controlled by the physical position detected by the at least one transducer (18, 19).

39. The gearshift of claim 37, wherein the transducer (18, 19) includes means for detecting the relative position between the selected actuator (16, 17), and the predetermined sprocket (11, 12) and for generating the information on the desired alignment.

40. The gearshift of claim 39, wherein the transducer is further suitable for generating the displacement request signal of the actuator (16, 17).

41. The gearshift of claim 39, wherein the means for detecting the relative position comprises a collimated light source and a collimated light sensor, cooperatively positioned at the actuator (16, 17) and at the predetermined sprocket (11, 12).

42. The gearshift of claim 30, wherein the rear and front actuators (16, 17) include stepper motors, and a displacement of the selected actuator (16, 17) corresponds to a unitary increase or decrease of the at least one counter (47, 48).

43. The gearshift of claim 27, further comprising means (60) for outputting information defining, with the manual input means (43-46, 60-63), a user interface with the electronic control unit (40).

44. The gearshift of claim 27, further comprising a power board (30) arranged between the electronic control unit (40) and the rear and front actuators (16, 17).

45. The gearshift of claim 27, wherein the electronic control unit (40) comprises at least one microcontroller made in C-MOS technology.

46. The gearshift of claim 27, wherein the electronic control unit (40) is distributed and comprises many microcontrollers at a display unit (60) and at a unit controlling the manual input means (43-47, 61-63) and at a power board (30).

47. A method for providing an adjustment operating mode (117) of an electronic control unit (40) for a servo-assisted bicycle gearshift system (8) comprising:

determining whether a gearshift displacement request is received (402, 410);  
determining whether a maximum displacement has been achieved (403, 408, 411, 415);

moving the gearshift to provide a displacement of the gearshift to achieve a desired physical gearshift position; and

modifying a value of an adjustment variable (404, 409, 412, 416), for modifying a logic value associated with a predetermined gear ratio, to be proportional to the displacement of the gearshift.

48. The method of claim 47, wherein the step of moving the gearshift include the step of actuating an actuator (16, 17).

49. The method of claim 47, further comprising determining the desired physical gearshift position using a position transducer (18, 19).

50. The method of claim 47, further comprising storing the value of the adjustment variable in a memory (49, 50) of the electronic control unit (40).

51. A bicycle gearshift system comprising:

at least one actuator (16,17) for displacing a transmission element from a first to at least a second sprocket;

at least a first input device (43, 44, 45, 46) for entering a displacement request signal and for selecting between operating modes (102, 114, 117);

an electronic control unit (40), for driving the actuator, in a first operating mode (102), in response to the displacement request signal, between a first logic value, as modified by an adjustment variable, associated with the first sprocket and at least a second logic value, as modified by the adjustment variable, associated with the second sprocket; and, in a second operating mode (114), for setting a biunique correspondence between a physical position of the actuator and a logic value associated with a predetermined sprocket; and, in a third operating mode (117), for modifying a value of the adjustment variable by a displacement of the gearshift corresponding to a desired alignment of the transmission element.

52. The bicycle gearshift system of claim 51, further comprising a second input device (43, 44, 45, 46) for inputting information on a desired alignment of the transmission element on the predetermined sprocket.

53. The bicycle gearshift system of claim 51, wherein the electronic control unit (40) includes a counter (47, 48) and wherein, in the second operating mode, the biunique correspondence is setable by setting a value of the counter to the logic value associated with the predetermined sprocket, and wherein in the first operating mode, the value of the counter is modifiable, in response to the displacement request signal, by an amount proportional to the difference between at least the first and second logic values plus the value of the adjustment variable, and the actuator is drivable a distance corresponding to the value of the counter.

54. The bicycle gearshift system of claim 53, wherein the electronic control unit (40) comprises memory (49, 50) for storing the value of the counter.

55. The bicycle gearshift system of claim 53, wherein the electronic control unit (40) comprises memory (49, 50) for storing at least one differential amount ( $\Delta R$ ,  $\Delta F$ ), associated with at least a pair of adjacent sprockets, for determining the logic value of a second one of the pair of sprockets in the first operating mode (102) by adding the logic value of a first one of the pair of sprockets to the differential amount ( $\Delta R$ ,  $\Delta F$ ) and the value of the adjustment variable.

56. The bicycle gearshift system of claim 51, wherein the at least one actuator comprises a front and rear actuator (17, 16) for actuating a front and rear derailleur respectively of a bicycle.

57. The bicycle gearshift system of claim 51, further comprising at least one position transducer (18, 19) for detecting the physical position of the actuator and transmitting a position signal to the electronic control unit.

58. The bicycle gearshift system of claim 51, further comprising a power board (30) for supplying power to at least the actuator and the electronic control unit.

59. The bicycle gearshift system of claim 51, further comprising a display unit (60) which is integral with the control unit (40) and the input device (43, 44, 45, 46).